PATENT SPECIFICATION

(11) 1 301 666

A5

DRAWINGS ATTACHED

1 301 666

(21) Application No. 6153/72 (22) Filed 9 May 1969
(62) Divided out of No. 1 301 665
(23) Complete Specification filed 5 May 1970
(44) Complete Specification Published 4 Jan. 1973
(51) International Classification B21D 53/04
(52) Index at acceptance
B3A 158 180
B3E 10A8 10C4 10D1 12 1G 1X6 4A 4E 5D

(72) Inventors HENRY JOHN LEVINGTON
CHARLES KEITH CLARK

(19)

(54) IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS

(71) We, ASSOCIATED ENGINEERING LIMITED, a British Company of 60, Kenilworth Road, Leamington Spa, Warwickshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a method and apparatus for forming a heat exchanger fin structure of the type disclosed in Figures 1 to 3 of our cognate co-pending applications Nos. 41849/67 and 18741/68 (Serial No. 1242397).

Such a fin structure comprises a metal strip, for example a strip of aluminum foil having a thickness of approximately 0.005", which is shaped to a corrugated form having areas forming fins alternating with and extending between regions intended to be bonded to heat-exchange members, which regions lie in two planes respectively located on opposite sides of the median longitudinal plane of the corrugated structure and having the fins inclined with respect to each other such that the adjacent fins extending from either side of a region converge towards each other.

The present invention provides apparatus for producing a fin structure consisting of a metal strip shaped to a corrugated form having areas forming fins alternating with and extending between regions which lie in two planes respectively located on opposite sides of the median longitudinal plane of the corrugated strips and having the fins inclined with respect to each other, such that the adjacent fins extending from either side of a region converge towards each other; said apparatus comprising means for holding said corrugated strip with the corrugations in a closed-up configuration, and pressing means comprising a base and a top tool, the base having a surface in one of the two planes and in contact with a number of the regions of the strip and the top tool having a surface in the other of the two planes and in contact with a number of the alternate regions of the strip, and means to subject the strip to an intermittent pressure between the top tool and the base, the pressure being applied in a direction substantially at right angles to the regions.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic representation of one embodiment of a press tool for forming corrugations and louvres in a metal strip.

Figure 2 is a section through a louvre in a partly-formed state,

Figure 3 is a diagrammatic drawing of one embodiment of apparatus for carrying out the method of forming converging fins according to the invention,

Figure 4 is a diagram of a section of the louvred and corrugated structure when partially formed.

Figure 5 is a diagram of the structure as prepared for a subsequent operation,

Figure 6 is a diagram illustrating the subsequent operation,

Figure 7 is a diagram of the structure after the operation of Figure 6,

Figure 8 is a perspective view of the completed corrugated fin structure,

Figure 9 is a section through a completed fin on the line IX-IX of Figure 8,

Figure 10 shows a modification to the press tool of Figure 1; and

Figure 11 is a diagrammatic view of a modification to the apparatus of Figures 3 and 6.

Referring to Fig. 1, there is shown diagrammatically one form of press tool for forming the corrugated structure and louvres. The continuous strip of metal 9 is fed in steps to the first tool section comprising a die cavity 10 and punch 11. When

the punch 11 descends into the die cavity 10, with the strip 9 held by spring-loaded plunger 16, one corrugation, having fin areas 1 joined by a region 2, is formed in the strip, which is drawn into the die cavity. The corrugation so formed is ejected from the die by ejector 12, and the strip is stepped forward, by a gripper mechanism G on each side of the press tool, by a distance corresponding to the pitch of the corrugations, so that the corrugation so formed enters the next tool section comprising the die cavity 13 and punch 14. This die cavity and punch are fashioned to co-operate together to partly form the louvres 7 and 8 (see Fig. 8) in the fin areas 1 of each corrugation. The louvres formed project only into the die 13 as shown in Fig. 2. The louvred corrugation is stripped from the punch 14 by spring-urged plungers 16 and 17, which are carried by the punch housing 18. The mechanism allows the punches 11, 14 to leave the strip before the ejector 15 ejects the part-louvred corrugation from the die 13. The corrugated strip is then transferred by the gripper mechanism G by one pitch to the next position, placing the part-louvred corrugation under the plunger 17. It is arranged that the plunger 17 enters the corresponding die 20 before the punches 11 and 14 are fully engaged, and provides a location and grip for the corrugated strip. The plunger 17 is also fashioned to complete the louvres 7 and 8, in the fin area 1 of the corrugation, so that the louvres extend on both sides of each of the fins 1 as seen in Fig. 9. The corrugated and louvred structure so formed is then ejected from the third die 20 by ejector 19. The corrugated and louvred structure so formed can then be fed to the apparatus to be described with reference to Fig. 3. The three press tool sections 10 and 11, 13 and 14, 17 and 20 can be operated together so that whilst a corrugation is being formed by the first tool, part louvres are being formed by the second tool, and the complete louvres are being formed by the third tool, the strip being stepped forward during the period when the punches are raised clear of the dies.

Referring now to Figure 3, the strip of metal foil, e.g. aluminium foil having a thickness of 0.005", is now in the form of a corrugated structure, comprising areas forming fins 1 alternating with and extending between regions 2 intended to be bonded to heat exchange members. The regions 2 lie alternately in two planes respectively located on opposite sides of the median longitudinal plane A-A of the corrugated structure. For the sake of simplicity, the louvres formed in the fins 1 have been omitted from Figure 3. This structure is fed through the gap between two endless belts 3, which pass over drive rollers 4 and have a section 3a in contact with the adjacent regions 2 of the corrugated structure. Thus, when the belts 3 are driven in rotation in opposite directions, the corrugated structure is fed through the gap between the belts in the direction of the arrows B. The corrugated structure is then fed through two restraining means comprising spring-urged plates 5 having shoulders 6 which can respectively engage with the corners 21 between each fin 1 and region 2 in order temporarily to restrain or stop the motion of the corrugated structure. The plates 5 are offset by a distance 0 equal to half the length of the regions 2 measured in the direction of motion. With this arrangement, as the corrugations pass between the belts 3 and approach the restraining means 5, they tend to close up on each other from their initial form in which the fins on either side of a region are divergent, and thereby cause at least the fin adjacent that held by the restraining means to incline towards the restrained fin. This closing up of the fins has the effect of stiffening the portion of the corrugated structure immediately preceding the restraining means and builds up a sufficient force to cause the plates 5 to yield to allow passage of the converged fins so formed. Thus, at the output side of the restraining means is formed a corrugated structure having the fins 1 extending from either side of a region 2 converging towards each other. Although the corrugations are fully closed in passing through the apparatus, they then spring slightly open again as seen in Fig. 4. To ensure that the structure in its finished form has the corrugations substantially fully closed, the structure is then held in the fully closed position and subjected to a pressing operation, the pressure being applied substantially at right angles to the regions 2. The pressing operation is carried out on the fins, when in the configuration shown in Fig. 5, by a press tool shown in Fig. 6 having a base 30 and a top tool 31, the latter being provided with solid side strips 32 which contact the base 30 and control the height of the pressed corrugated structure. This emerges from the press tool with the regions 2 flattened, and the angles between regions 2 and fins 1 sharpened, as shown in Fig. 7.

Figure 8 is a perspective view of a part of the resulting fin structure also showing the louvres 7, 8. The louvres in each fin 1 are divided into two groups with the louvres 7 in one group inclined in the opposite direction to the louvres 8 in the other group and with all the louvres projecting from both sides of the plane of the fin.

Figure 9 shows a section through the fin in the region of the louvres and also shows the saw-tooth shape of the louvre-forming

portions of the die cavity 13 and punch 14 which are employed so as completely to form the louvres so that they extend from both sides of the fins, as described hereinafter with reference to Figure 10.

It will be understood that various modifications may be made. For example, other means may be used for forming corrugations in the strip besides the tool shown in Figure 1. Moreover other arrangements of louvres may be provided instead of that specifically described.

In one modification of the press tool shown in Fig. 1 for forming the corrugations and louvres in the metal strip, the first tool section comprising die cavity 10 and punch 11 are omitted and die cavity 13 and punch 14 are employed both to form the corrugations in the strip 9 and also simultaneously to partially form the louvres. The plunger 17 and die cavity 20 complete the formation of the louvres as previously.

A further modified form of the press tool is shown in Figure 10, wherein corresponding parts bear the same reference numerals as in Fig. 1. In this construction the die cavity 13 and punch 14 are employed both to form the corrugations and completely to form the louvres so that they extend from both sides of the fins, as shown in Fig. 9. The ejector 12 is continued up to the line of the incoming foil strip 9 and is associated with a gate 12*a* to control the vertical movement of the strip. The ejector 12 works up and down in conjunction with ejectors 15 and 19. The plunger 17 is used only for location purposes and is relieved at 17*a* so as not to foul the louvres, but serves to clamp the fin sections into the die cavity 20 by engaging the flat portions of the fins.

In another modification shown in Figure 11, the pressing operation described with reference to Fig. 6 may be carried out by arranging the press tool immediately following the spring-urged plates 5. In this case the side strips 32 (Fig. 6) are preferably attached to the base 30 and the top plate 31*a* is spring-loaded by springs 34 and is hammered on to the side strips 32 by means of a cam 33 driven, e.g. by an electric motor, at a speed of about 1000 r.p.m. or higher. A further spring-urged plate 5*a* is positioned after the intermittent pressing or hammering station to maintain the fin form in the fully closed position during this operation.

In yet a further modification, the spring-urged plates 5 may be replaced by guide plates 25 (shown in broken lines in Figure 11), movement of the strip being restrained by a single spring-urged plate 5*a* downstream of the intermittent pressing or hammering station 30, 31a (or alternatively by two plates 5*a*, one co-operating with each set of regions 2 of the strip).

Our copending applications Nos. 23835/69 and 6154/72 (Serial No. 1301665 and 1301667) claim other features disclosed herein.

WHAT WE CLAIM IS:—

1. Apparatus for producing a fin structure consisting of a metal strip shaped to a corrugated form having areas forming fins alternating with and extending between regions which lie in two planes respectively located on opposite sides of the median longitudinal plane of the corrugated strip and having the fins inclined with respect to each other, such that the adjacent fins extending from either side of a region converge towards each other; said apparatus comprising means for holding said corrugated strip with the corrugations in a closed-up configuration, and pressing means comprising a base and a top tool, the base having a surface in one of the two planes and in contact with a number of the regions of the strip and the top tool having a surface in the other of the two planes and in contact with a number of the alternate regions of the strip, and means to subject the strip to an intermittent pressure between the top tool and the base, the pressure being applied in a direction substantially at right angles to the regions.

2. Apparatus as claimed in claim 1, wherein said means to subject the strip to an intermittent pressure includes a cam arranged on each rotation to load the top tool relative to the base, and means to rotate the cam.

3. Apparatus as claimed in claim 1, substantially as hereinbefore described with reference to Figure 6 or Figure 11 of the accompanying drawings.

4. Corrugated fin structures produced by the apparatus according to any of the preceding claims.

BARON & WARREN,
16, Kensington Square,
London, W.8.

Chartered Patent Agents.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1972.
Published at the Patent Office, 25 Southampton Buildings, London WC2A 1AY from which copies may be obtained.

1,301,666
3 SHEETS

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale.

SHEET 1

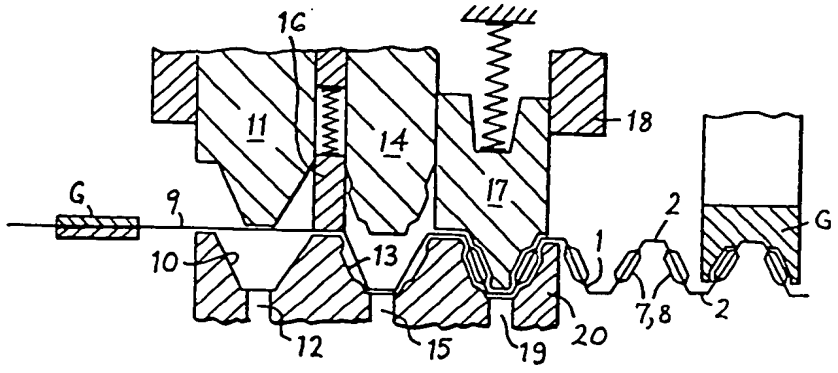


Fig.1

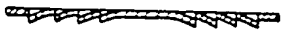


Fig.2

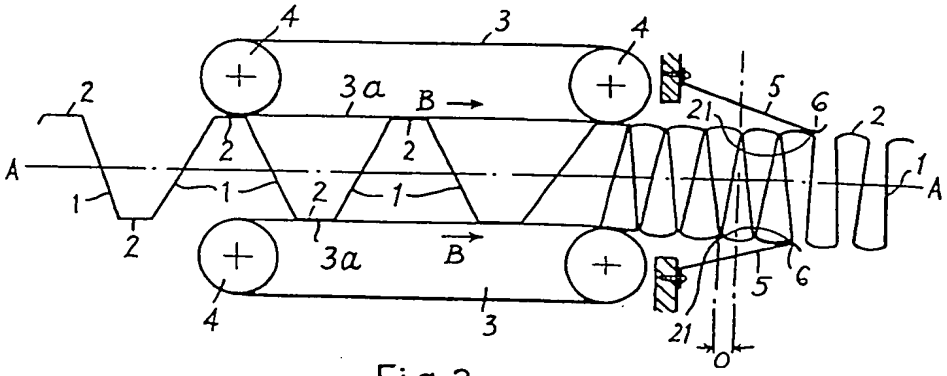


Fig.3

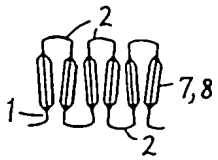


Fig.4

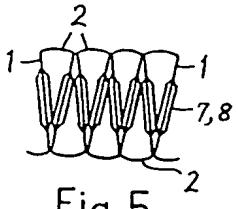


Fig.5

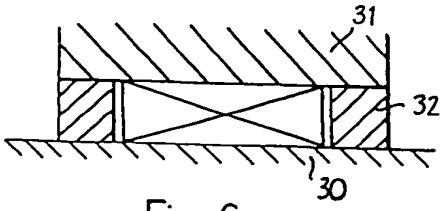


Fig.6

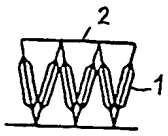
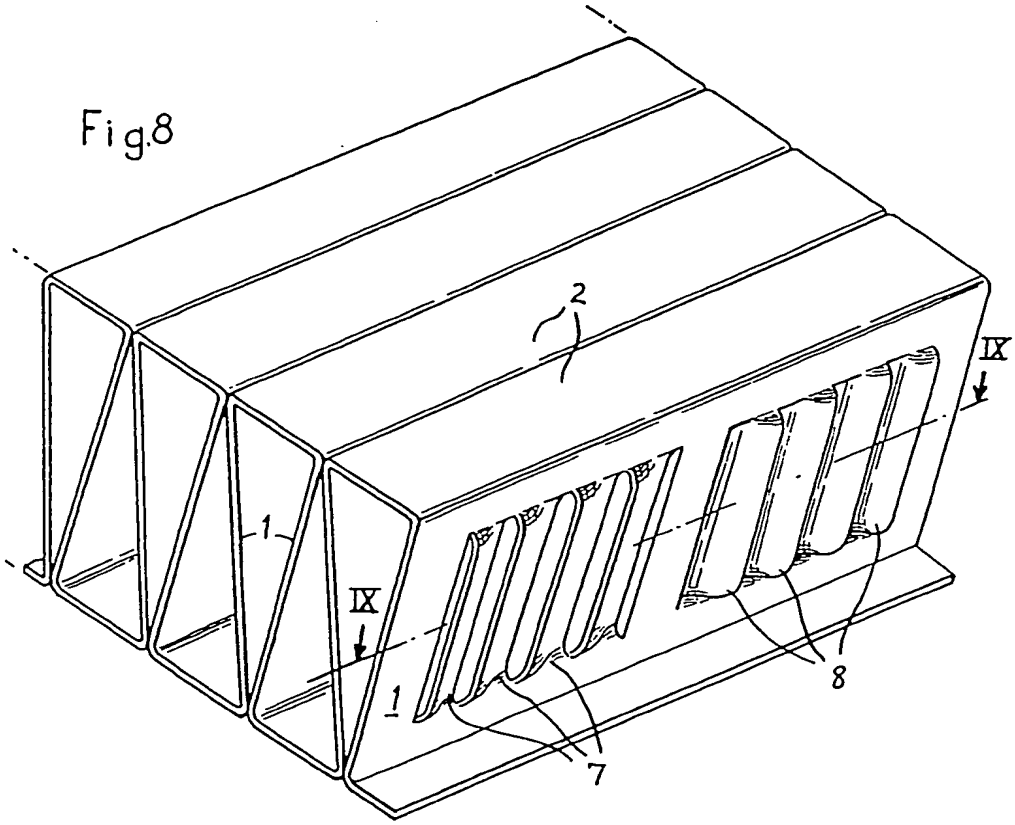


Fig.7

Fig.8



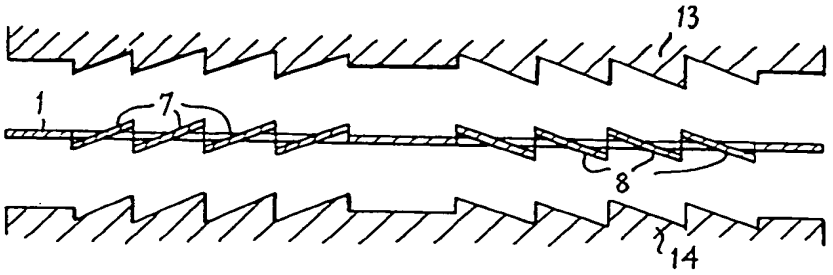


Fig.9

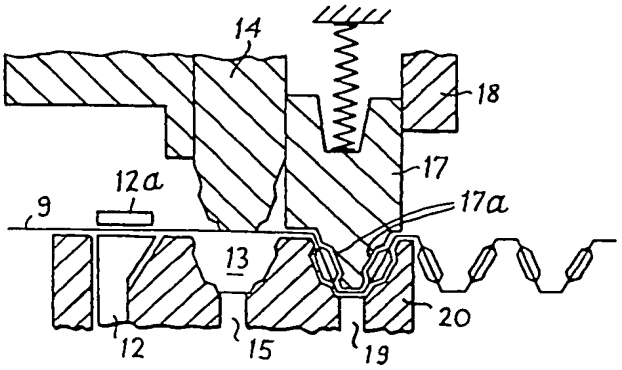


Fig.10

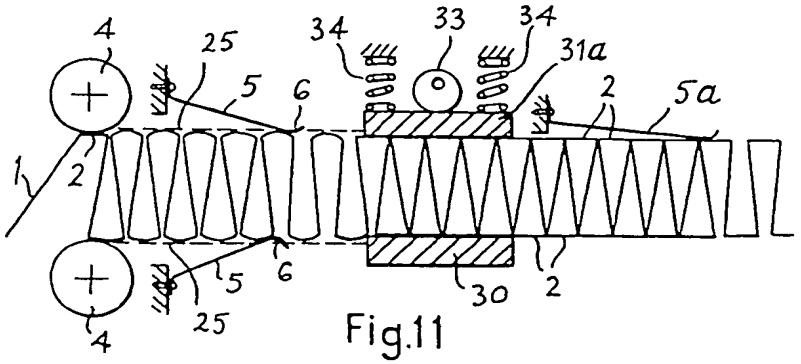


Fig.11